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JC903 U.S. PRO

Practitioner's Docket No. FEC-11704

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Box Patent Application  
Assistant Commissioner for Patents  
Washington, D.C. 20231

JC903 U.S. PRO  
09/650824  
08/30/00

NEW APPLICATION TRANSMITTAL

Transmitted herewith for filing is the patent application of

Inventor(s): Robert H. Martter et al.

**WARNING:** 37 CFR 1.41(a)(1) points out:

*"(a) A patent is applied for in the name or names of the actual inventor or inventors.*

*(1) The inventorship of a nonprovisional application is that inventorship set forth in the oath or declaration as prescribed by § 1.63, except as provided for in § 1.53(d)(4) and § 1.63(d). If an oath or declaration as prescribed by § 1.63 is not filed during the pendency of a nonprovisional application, the inventorship is that inventorship set forth in the application papers filed pursuant to § 1.53(b), unless a petition under this paragraph accompanied by the fee set forth in § 1.17(i) is filed supplying or changing the name or names of the inventor or inventors."*

For (title): CIRCUIT BOARD

**1. Type of Application**

This new application is for a(n)

*(check one applicable item below)*

- ☒ Original (nonprovisional)
- ☐ Design
- ☐ Plant

**WARNING:** *Do not use this transmittal for a completion in the U.S. of an International Application under 35 U.S.C. 371(c)(4), unless the International Application is being filed as a divisional, continuation or continuation-in-part application.*

**WARNING:** *Do not use this transmittal for the filing of a provisional application.*

09/650824-00000000

NOTE: If one of the following 3 items apply, then complete and attach **ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF A PRIOR U.S. APPLICATION CLAIMED** and a **NOTIFICATION IN PARENT APPLICATION OF THE FILING OF THIS CONTINUATION APPLICATION**.

- ☐ Divisional.  
☐ Continuation.  
☐ Continuation-in-part (C-I-P).

## 2. Benefit of Prior U.S. Application(s) (35 U.S.C. 119(e), 120, or 121)

NOTE: A nonprovisional application may claim an invention disclosed in one or more prior filed copending nonprovisional applications or copending international applications designating the United States of America. In order for a nonprovisional application to claim the benefit of a prior filed copending nonprovisional application or copending international application designating the United States of America, each prior application must name as an inventor at least one inventor named in the later filed nonprovisional application and disclose the named inventor's invention claimed in at least one claim of the later filed nonprovisional application in the manner provided by the first paragraph of 35 U.S.C. 112. Each prior application must also be:

(i) An international application entitled to a filing date in accordance with PCT Article 11 and designating the United States of America; or

(ii) Complete as set forth in § 1.51(b); or

(iii) Entitled to a filing date as set forth in § 1.53(b) or § 1.53(d) and include the basic filing fee set forth in § 1.16; or

(iv) Entitled to a filing date as set forth in § 1.53(b) and have paid therein the processing and retention fee set forth in § 1.21(l) within the time period set forth in § 1.53(f).

37 CFR 1.78(a)(1).

NOTE If the new application being transmitted is a divisional, continuation or a continuation-in-part of a parent case, or where the parent case is an International Application which designated the U.S., or benefit of a prior provisional application is claimed, then check the following item and complete and attach **ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED**.

**WARNING:** If an application claims the benefit of the filing date of an earlier filed application under 35 U.S.C. 120, 121 or 365(c), the 20-year term of that application will be based upon the filing date of the earliest U.S. application that the application makes reference to under 35 U.S.C. 120, 121 or 365(c). (35 U.S.C. 154(a)(2) does not take into account, for the determination of the patent term, any application on which priority is claimed under 35 U.S.C. 119, 365(a) or 365(b).) For a c-i-p application, applicant should review whether any claim in the patent that will issue is supported by an earlier application and, if not, the applicant should consider canceling the reference to the earlier filed application. The term of a patent is not based on a claim-by-claim approach. See Notice of April 14, 1995, 60 Fed. Reg. 20,195, at 20,205.

**WARNING:** When the last day of pendency of a provisional application falls on a Saturday, Sunday, or Federal holiday within the District of Columbia, any nonprovisional application claiming benefit of the provisional application **must** be filed prior to the Saturday, Sunday, or Federal holiday within the District of Columbia. See 37 C.F.R. § 1.78(a)(3).

- ☐ The new application being transmitted claims the benefit of prior U.S. application(s). Enclosed are **ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED**.

3. **Papers Enclosed**

A. **Required for Filing Date under 37 C.F.R. 1.53(b) (Regular) or 37 C.F.R. 1.153 (Design) Application**

  6   Pages of Specification  
  2   Pages of Claims  
  3   Sheets of Drawing  
      [ ] Formal  
      [X] Informal

B. **Other Papers Enclosed**

  1   Pages of Abstract  
\_\_\_\_\_ Other

**WARNING:** *DO NOT* submit original drawings. A high quality copy of the drawings should be supplied when filing a patent application. The drawings that are submitted to the Office must be on strong, white, smooth, and non-shiny paper and meet the standards according to § 1.84. If corrections to the drawings are necessary, they should be made to the original drawing and a high-quality copy of the corrected original drawing then submitted to the Office. Only one copy is required or desired. For comments on proposed then-new 37 C.F.R. 1.84, see Notice of March 9, 1988 . . . (1990 O.G. 57-62).

**NOTE:** "Identifying indicia, if provided, should include the application number or the title of the invention, inventor's name, docket number (if any), and the name and telephone number of a person to call if the Office is unable to match the drawings to the proper application. This information should be placed on the back of each sheet of drawing a minimum distance of 1.5 cm. (5/8 inch) down from the top of the page." 37 C.F.R. 1.84(c)).

(complete the following, if applicable)

[ ] The enclosed drawing(s) are photograph(s), and there is also attached a "PETITION TO ACCEPT PHOTOGRAPH(S) AS DRAWING(S)." 37 C.F.R. 1.84(b).

4. **Additional Papers Enclosed**

[ ] Preliminary Amendment  
[ ] Information Disclosure Statement (37 C.F.R. 1.98)  
[ ] Form PTO-1449 (PTO/SB/08A and 08B)  
[ ] Citations  
[ ] Declaration of Biological Deposit  
[ ] Submission of "Sequence Listing," computer readable copy and/or amendment pertaining thereto for biotechnology invention containing nucleotide and/or amino acid sequence.  
[ ] Authorization of Attorney(s) to Accept and Follow Instructions from Representative  
[ ] Special Comments  
[ ] Other

## 5. Declaration or Oath

**NOTE:** *A newly executed declaration is not required in a continuation or divisional application provided the prior nonprovisional application contained a declaration as required, the application being filed is by all or fewer than all the inventors named in the prior application, there is no new matter in the application being filed, and a copy of the executed declaration filed in the prior application (showing the signature or an indication thereon that it was signed) is submitted. The copy must be accompanied by a statement requesting deletion of the names of person(s) who are not inventors of the application being filed. If the declaration in the prior application was filed under § 1.47 then a copy of that declaration must be filed accompanied by a copy of the decision granting § 1.47 status or, if a nonsigning person under § 1.47 has subsequently joined in a prior application, then a copy of the subsequently executed declaration must be filed. See 37 CFR 1.63(d).*

**NOTE:** *A declaration filed to complete an application must be executed, identify the specification to which it is directed, identify each inventor by full name, including the family name, and at least one given name without abbreviation together with any other given name or initial, and the residence, post office address and country of citizenship of each inventor and state whether the inventor is a sole or joint inventor. 37 CFR 1.63(a)(1)-(4).*

☐ Enclosed  
Executed by

(check **all** applicable boxes)

- ☐ inventor(s).  
☐ legal representative of inventor(s). 37 CFR 1.42 or 1.43.  
☐ joint inventor or person showing a proprietary interest on behalf of inventor who refused to sign or cannot be reached.  
☐ This is the petition required by 37 CFR 1.47 and the statement required by 37 CFR 1.47 is also attached. See item 13 below for fee.

☒ Not Enclosed.

**NOTE:** *Where the filing is a completion in the U.S. of an International Application, or where the completion of the U.S. application contains subject matter in addition to the International Application, the application may be treated as a continuation or continuation-in-part, as the case may be, utilizing ADDED PAGE FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION CLAIMED.*

☒ Application is made by a person authorized under 37 C.F.R. 1.41(c) on behalf of *all* the above named inventor(s).

(The declaration or oath, along with the surcharge required by 37 CFR 1.16(e),  
can be filed subsequently).

**NOTE:** *It is important that all the correct inventor(s) are named for filing under 37 CFR 1.41(c) and 1.53(b).*

☐ Showing that the filing is authorized.  
(not required unless called into question. 37 CFR 1.41(d))

## 6. Inventorship Statement

**WARNING:** *If the named inventors are each not the inventors of all the claims an explanation, including the ownership of the various claims at the time the last claimed invention was made, should be submitted.*

The inventorship for all the claims in this application are:

☒ The same.

or

☐ Not the same. An explanation, including the ownership of the various claims at the time the last claimed invention was made,

☐ is submitted.

☐ will be submitted.

## 7. Language

*NOTE: An application including a signed oath or declaration may be filed in a language other than English. An English translation of the non-English language application and the processing fee of \$130.00 required by 37 CFR 1.17(k) is required to be filed with the application, or within such time as may be set by the Office. 37 CFR 1.52(d).*

☒ English

☐ Non-English

☐ The attached translation includes a statement that the translation is accurate. 37 C.F.R. 1.52(d).

8. Assignment

☒ An assignment of the invention to The Erie Ceramic Arts Company

☐ is attached. A separate ☐ "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or ☐ FORM PTO 1595 is also attached.

☒ will follow.

NOTE: "If an assignment is submitted with a new application, send two separate letters—one for the application and one for the assignment" Notice of May 4, 1990 (1114 O.G. 77-78).

WARNING: A newly executed "STATEMENT UNDER 37 CFR 3.73(b)" must be filed when a continuation-in-part application is filed by an assignee. Notice of April 30, 1993, 1150 O.G. 62-64.

9. Certified Copy

Certified copy(ies) of application(s)

Country	Appln. no.	Filed
Country	Appln. no.	Filed
Country	Appln. no.	Filed

from which priority is claimed

☐ is (are) attached.  
☐ will follow.

NOTE: The foreign application forming the basis for the claim for priority must be referred to in the oath or declaration. 37 CFR 1.55(a) and 1.63.

NOTE: This item is for any foreign priority for which the application being filed directly relates. If any parent U.S. application or International Application from which this application claims benefit under 35 U.S.C. 120 is itself entitled to priority from a prior foreign application, then complete item 18 on the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

10. **Fee Calculation** (37 C.F.R. 1.16)

A. ☒ Regular application

CLAIMS AS FILED					
Claims	Number Filed	Basic Fee Allowance	Number Extra	Rate	Basic Fee 37 C.F.R. 1.16(a) \$760.00
Total Claims (37 CFR 1.16(c))	18	- 20 =	0	x	\$ 18.00
Independent Claims (37 CFR 1.16(b))	3	- 3 =	0	x	\$ 78.00
Multiple Dependent Claim(s), if any (37 CFR 1.16(d))				+	\$260.00

- ☐ Amendment cancelling extra claims is enclosed.  
☐ Amendment deleting multiple-dependencies is enclosed.  
☐ Fee for extra claims is not being paid at this time.

NOTE: If the fees for extra claims are not paid on filing they must be paid or the claims cancelled by amendment, prior to the expiration of the time period set for response by the Patent and Trademark Office in any notice of fee deficiency. 37 CFR 1.16(d).

Filing Fee Calculation \$ 760.00

B. ☐ Design application  
(\$330.00—37 CFR 1.16(f))

Filing Fee Calculation \$ \_\_\_\_\_

C. ☐ Plant application  
(\$540.00—37 CFR 1.16(g))

Filing Fee Calculation \$ \_\_\_\_\_

11. **Small Entity Statement(s)**

- ☐ Statement(s) that this is a filing by a small entity under 37 CFR 1.9 and 1.27 is (are) attached.

**WARNING:** "Status as a small entity must be specifically established in each application or patent in which the status is available and desired. Status as a small entity in one application or patent does not affect any other application or patent, including applications or patents which are directly or indirectly dependent upon the application or patent in which the status has been established. The refiling of an application under § 1.53 as a continuation,

division, or continuation-in-part (including a continued prosecution application under § 1.53(d)), or the filing of a reissue application requires a new determination as to continued entitlement to small entity status for the continuing or reissue application. A nonprovisional application claiming benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) of a prior application, or a reissue application may rely on a statement filed in the prior application or in the patent if the nonprovisional application or the reissue application includes a reference to the statement in the prior application or in the patent or includes a copy of the statement in the prior application or in the patent and status as a small entity is still proper and desired. The payment of the small entity basic statutory filing fee will be treated as such a reference for purposes of this section." 37 CFR 1.28(a)(2).

(complete the following, if applicable)

☐ Status as a small entity was claimed in prior application  
\_\_\_\_\_/\_\_\_\_\_, filed on \_\_\_\_\_ from which benefit is being  
claimed for this application under:

35 U.S.C. § ☐ 119(e),  
☐ 120,  
☐ 121,  
☐ 365(c),

and which status as a small entity is still proper and desired.

☐ A copy of the statement in the prior application is included.

Filing Fee Calculation (50% of A, B or C above) \$ \_\_\_\_\_

NOTE: Any excess of the full fee paid will be refunded if a small entity status is established refund request are filed within 2 months of the date of timely payment of a full fee. The two-month period is not extendable under § 1.136. 37 CFR 1.28(a).

**12. Request for International-Type Search (37 C.F.R. 1.104(d))**

(complete, if applicable)

☐ Please prepare an international-type search report for this application at the time when national examination on the merits takes place.

**13. Fee Payment Being Made at This Time**

☒ Not Enclosed

☒ No filing fee is to be paid at this time.  
(This and the surcharge required by 37 C.F.R. 1.16(e) can be paid subsequently.)



☐ Enclosed

☐ Filing fee \$ \_\_\_\_\_

☐ Recording assignment  
(\$40.00; 37 C.F.R. 1.21(h))  
(See attached "COVER SHEET FOR  
ASSIGNMENT ACCOMPANYING NEW  
APPLICATION.") \$ \_\_\_\_\_

☐ Petition fee for filing by other  
than all the inventors or person  
on behalf of the inventor where  
inventor refused to sign or cannot  
be reached  
(\$130.00; 37 C.F.R. 1.47 and 1.17(i)) \$ \_\_\_\_\_

☐ For processing an application with a  
specification in a non-English language  
(\$130.00; 37 C.F.R. 1.52(d) and 1.17(k)) \$ \_\_\_\_\_

☐ Processing and retention fee  
(\$130.00; 37 C.F.R. 1.53(d) and 1.21(l)) \$ \_\_\_\_\_

☐ Fee for international-type search report  
(\$40.00; 37 C.F.R. 1.21(e)) \$ \_\_\_\_\_

NOTE: 37 CFR 1.21(l) establishes a fee for processing and retaining any application that is abandoned for failing to complete the application pursuant to 37 CFR 1.53(f) and this, as well as the changes to 37 CFR 1.53 and 1.78(a)(1), indicate that in order to obtain the benefit of a prior U.S. application, either the basic filing fee must be paid, or the processing and retention fee of § 1.21(l) must be paid, within 1 year from notification under § 53(f).

Total Fees Enclosed \$ \_\_\_\_\_

#### 14. Method of Payment of Fees

☐ Check in the amount of \$ \_\_\_\_\_.

☐ Charge Account No. \_\_\_\_\_ in the amount of \$ \_\_\_\_\_.  
A duplicate of this transmittal is attached.

NOTE: Fees should be itemized in such a manner that it is clear for which purpose the fees are paid. 37 CFR 1.22(b).

## 15. Authorization to Charge Additional Fees

**WARNING:** If no fees are to be paid on filing, the following items should not be completed.

**WARNING:** Accurately count claims, especially multiple dependent claims, to avoid unexpected high charges, if extra claim charges are authorized.

☐ The Commissioner is hereby authorized to charge the following additional fees by this paper and during the entire pendency of this application to Account No. \_\_\_\_\_.

☐ 37 C.F.R. 1.16(a), (f) or (g) (filing fees)

☐ 37 C.F.R. 1.16(b), (c) and (d) (presentation of extra claims)

**NOTE:** Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 CFR 1.16(d)), it might be best not to authorize the PTO to charge additional claim fees, except possibly when dealing with amendments after final action.

☐ 37 C.F.R. 1.16(e) (surcharge for filing the basic filing fee and/or declaration on a date later than the filing date of the application)

☐ 37 CFR 1.17(a)(1)-(5) (extension fees pursuant to § 1.136(a).

☐ 37 C.F.R. 1.17 (application processing fees)

**NOTE:** "A written request may be submitted in an application that is an authorization to treat any concurrent or future reply, requiring a petition for an extension of time under this paragraph for its timely submission, as incorporating a petition for extension of time for the appropriate length of time. An authorization to charge all required fees, fees under § 1.17, or all required extension of time fees will be treated as a constructive petition for an extension of time in any concurrent or future reply requiring a petition for an extension of time under this paragraph for its timely submission. Submission of the fee set forth in § 1.17(a) will also be treated as a constructive petition for an extension of time in any concurrent reply requiring a petition for an extension of time under this paragraph for its timely submission." 37 CFR 1.136(a)(3).

☐ 37 C.F.R. 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. 1.311(b))

**NOTE:** Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of allowance. 37 CFR 1.311(b)).

**NOTE:** 37 CFR 1.28(b) requires "Notification of any change in status resulting in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying, . . . issue fee." From the wording of 37 CFR 1.28(b), (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

**16. Instructions as to Overpayment**

*NOTE: "... Amounts of twenty-five dollars or less will not be returned unless specifically requested within a reasonable time, nor will the payer be notified of such amounts; amounts over twenty-five dollars may be returned by check or, if requested, by credit to a deposit account." 37 CFR 1.26(a).*

☐ Credit Account No. \_\_\_\_\_.

☐ Refund



**SIGNATURE OF PRACTITIONER**

Kenneth A. Clark

RANKIN, HILL, PORTER & CLARK LLP

*(type or print name of practitioner)*

Reg. No. 32,119

Tel. No.: 216-566-9700

925 Euclid Avenue, Suite 700

P.O. Address

Customer No.: 007609

Cleveland, Ohio 44115-1405

☐ **Incorporation by reference of added pages**

*(check the following item if the application in this transmittal claims the benefit of prior U.S. application(s) (including an international application entering the U.S. stage as a continuation, divisional or C-I-P application) and complete and attach the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED)*

- ☐ Plus Added Pages for New Application Transmittal Where Benefit of Prior U.S. Application(s) Claimed

Number of pages added \_\_\_\_\_

- ☐ Plus Added Pages for Papers Referred to in Item 4 Above

Number of pages added \_\_\_\_\_

- ☐ Plus added pages deleting names of inventor(s) named on prior application(s) who is/are no longer inventor(s) of the subject matter claimed in this application.

Number of pages added \_\_\_\_\_

- ☐ Plus "Assignment Cover Letter Accompanying New Application"

Number of pages added \_\_\_\_\_

☒ **Statement Where No Further Pages Added**

*(if no further pages form a part of this Transmittal, then end this Transmittal with this page and check the following item)*

- ☒ This transmittal ends with this page.

Title: **CIRCUIT BOARD**

### **Field Of The Invention**

This invention relates to electrical circuit devices comprising porcelain enameled coated metal substrates such as printed circuit boards wherein conductive patterns are applied to the surfaces of the porcelain enameled coated metal substrates. In particular, the invention relates to forming high strength solder connections between a flexible conductor, for example, a wire or the lead of an electronic component and the printed circuit boards formed of porcelain enamel coated metal substrates. The invention also relates to the devices formed in accordance with the methods of the invention.

### **Background Of The Invention**

Many modern printed circuit cards comprise substrates formed of porcelain enameled metal. Circuits are formed on the substrates using conductive, dielectric or other resistive materials.

The resulting coated metal substrate can be used for circuit boards, thermal sinks, thermal barriers, RF shielding, magnetic flux conduction, mechanical attachments and other related applications. Such coated metal substrates that are coated with a porcelain enameled material are commonly referred to as porcelain enameled metal substrates (PEMS).

Discrete circuit patterns can be formed on the PEMS by conventional techniques such as screen printing, firing, etc. The circuit patterns can serve as switch contacts, circuit traces to carry current, and terminals for interconnection of external wires. The circuit patterns may be formed on one or both sides of the substrate.

In the prior art, in order to attach a wire or other conductor such as a lead to the circuit formed on the PEMS, an aperture would be created in the substrate, the wire or conductor would then be inserted into the aperture, and the wire or conductor would be soldered to the electrical circuit. Alternatively, the wire or lead was soldered to a pad formed by thick film material on the surface of the substrate. However, these conventional soldering techniques resulted in weak joints. The weakness of the solder joint at the connection is a very common problem. Typically the strength of the solder joint on these electrical circuit devices are less than half the pull strength of similar solder joints on electrical circuit devices comprised of, for example, alumina ceramic. Thus, a need exists for a method to secure conductors to a PEMS that provides high mechanical strength and durability as well as good electrical conductivity.

### **Summary Of The Invention**

In view of the aforementioned needs, the invention contemplates a durable, high strength interface or connection between a printed circuit board comprised of porcelain enamel coated metal substrates and an external conductor such as a wire or a lead of an external electronic component.

In the method of the present invention, an aperture is first created in the substrate. The aperture is formed in a manner to ensure that the metal substrate is electrically insulated from the aperture. Then, an eyelet is inserted into the aperture. The eyelet is usually crimped, but other means are available that will cause the eyelet to be mechanically retained in the aperture and form an electrical connection between the eyelet and circuitry formed on the surface of the printed circuit board. A conductor is then inserted into the eyelet and then soldered to the eyelet such that the thick film adjoins the eyelet. The addition of an eyelet to the soldered joint connection mechanically reinforces the solder joint and provides unexpected vastly improved mechanical strength to the joint.

Among those benefits and improvements that have been disclosed, other objects and advantages of this invention will become apparent from the following description taken in conjunction with the accompanying drawings. The drawings constitute a part of this specification and include exemplary embodiments of the present invention and illustrate various objects and features thereof.

### **Brief Description Of The Drawings**

Figure 1 shows a top view of a circuit board embodiment according to the present invention;

Figure 1A shows a top view of the circuit board of Figure 1 with the leads mounted to the board;

Figure 1B is a schematic broken-away cross-sectional view of a portion of a circuit board made in accordance with the present invention;

Figure 2 shows a schematic broken-away cross-sectional view taken showing a portion of a circuit board made in accordance with the present invention wherein the metal substrate is electrically insulated from the hollow mechanical fastener;

Figure 3 shows a cross-sectional view of an embodiment according to the present invention wherein the metal substrate is in electrical contact with the hollow mechanical fastener; and

Figure 4 shows a cross-sectional view of a embodiment of the invention wherein the metal substrate is electrically insulated from the hollow mechanical fastener.

### **Detailed Description Of The Invention**

Referring more particularly to the drawings and initially to Figures 1, 1A and 1B, there is shown a portion of an electrical circuit device 10 having a conductive and supportive metal substrate or base 11. In a preferred embodiment, base 11 comprises a steel substrate coated along the top 12 and bottom 13 surfaces with porcelain enamel 14. In each of the drawings 1-4, the same reference

numerals have been utilized to identify similar elements. The porcelain enamel coated steel substrates are commercially available from the ECA Electronics Company located in Erie, Pa. In addition to a porcelain enameled steel substrate, it will be appreciated that base **11** may comprise any number of other conventional metal substrate materials such as, for example, low carbon steel, stainless steel or aluminum.

Device **10** include conductive circuit patterns **16** formed on at least one surface of the dielectric material or enamel **14**. Methods for forming the circuit patterns on the substrate are well known to those skilled in the art, such as screen printing, firing, etc. See U.S. Patent No. 5,605,715 issued to Giardina, et al. or U.S. Patent No. 5,554,965 issued to Sundberg which applicant hereby incorporates by reference for additional examples of methods used for forming circuit patterns on porcelain enameled metal substrates. The methods for forming the conductive circuit patterns on dielectric materials such as porcelain enamel are well-known in the art, and are not limited to those methods specifically disclosed herein.

Referring once again to Figure **1B** an aperture **17** is created in the base **11** and the enamel **14** in order for an external conductor to be connected to the circuit device **10**. A hollow mechanical fastener, normally a metal eyelet **20**, is then inserted into the aperture. A typical eyelet suitable for use with this invention is sold by Keystone Electronics Corp, 31-07 20th Road, Astoria, NY 11105. Eyelets are available in a variety of sizes so as to accommodate a variety of aperture opening sizes and lead sizes. Eyelets that are pre-scored, that is grooves are placed in the eyelet for easy separation upon crimping, are also available. Pre-scored eyelets are available commercially from Mark Eyelet and Stamping, 63 Wakelee Road, Wolcot, Conn. Similarly, "solder through" eyelets, that is special eyelets which utilize capillary action to carry molten solder from the bottom side of a printed circuit board eyelet in a single operation are commercially available. These fasteners or eyelets are



Conn. Similarly, "solder through" eyelets, that is special eyelets which utilize capillary action to carry molten solder from the bottom side of a printed circuit board eyelet in a single operation are commercially available. Fasteners are available in a variety of materials, for example, brass, aluminum, steel and copper.

5            Since the typical hollow mechanical fastener or eyelet is comprised of metal, means to electrically insulate the steel substrate **11** from the eyelet **20** are necessary to prevent the eyelet from short circuiting the circuit patterns **16** to the substrate **11**. As illustrated in Figure **2**, one method of doing this is by coating or covering walls of the opening **17** of the steel substrate **11** with the dielectric enamel material **15**. As shown in Figure **3**, in applications where it may be desirable not to electrically isolate the fastener **20** from the base **11**, the base **11** can be allowed to contact or engage the fastener **20**. A further alternative embodiment is illustrated in Figure **4**, wherein the steel substrate **11** is insulated from the aperture **20** by a nonconductive sleeve **25**. Such sleeve **25** is formed of a flexible material such as silicone or an elastomer.

10            The hollow mechanical fastener **20** is preferably mechanically fastened to the electrical circuit device **10**. The method of fastening is dependent on the type of fastener used. The typical eyelet is flanged on one end **30** and then inserted into the hole or aperture **17**. The opposite end **34** of the eyelet is then crimped, causing the eyelet to deform by forcing the metal to expand, forming an annular ring which is larger than the hole **17** and the annular ring is compressed against the circuit pattern **16**, making mechanical contact with the surface of the board, thereby mechanically holding the eyelet in place and preventing the eyelet from sliding back through the hole **17**. However, several other methods of mounting are available such as soldering, threading the opposite end of the fastener and utilizing a nut, insertion of a sleeve inside the hollow metallic fastener with a flanged end that

is secured with clips, retaining pins, or a compression fitting. As there are many different methods known to those skilled in the art, this list is meant to be illustrative, not exhaustive or exclusive.

Once eyelet **20** is mounted, a (metal wire such as a conventional flexible copper wire) metal conductor **50** is then inserted inside the eyelet **20**. Solder **52** is then applied to the joint to form a permanent mechanical and electrical connection. In the preferred embodiment, additional solder **52** is applied so that the conductor **50**, eyelet **20**, and conductive circuit **16** are all permanently electrically and mechanically connected on the electrical circuit device **10** as shown in Figure 2. If desired, the conductor **50** may also be soldered to the opposite surface of the eyelet **20**, or similarly to the eyelet on the opposite surface of the circuit device **10** and any circuitry on that side. This invention does not contemplate that a specific surface on the electric circuit device must be used, any or all surfaces may be used.

Although the invention has been shown and described with respect to preferred embodiments, it is obvious that equivalent alterations and modifications will occur to others skilled in the art upon reading and understanding the specification. The present invention includes all such equivalent alterations and modifications, and is limited only by the scope of the following claims.

What is claimed is:

1. A method for connecting an external electrical conductor to a porcelain enameled metal substrate electrical circuit device comprising:

(a) providing a porcelain enameled metal substrate having an aperture formed therein;

(b) inserting a hollow mechanical fastener through the aperture;

(c) mechanically fastening the fastener to the metal substrate so as to form an eyelet;

(d) inserting the external electrical conductor into the eyelet;

(e) applying solder to the external electrical conductor and the eyelet.

2. The method in claim 1 wherein the external electrical conductor is a wire.

3. The method in claim 2 wherein the eyelet is comprised of brass.

4. The method in claim 3 wherein the eyelet is electrically connected to a conductor on at least one surface of the electrical circuit device.

5. The method in claim 4 wherein the eyelet is soldered to at least one surface of the electrical circuit device.

6. The method in claim 1 wherein the external electrical conductor is a lead to an electronic component.

7. The method in claim 6 wherein the eyelet is comprised of brass.

8. The method in claim 7 wherein the eyelet is electrically connected to a conductor on at least one surface of the electrical circuit device.

9. The method in claim 8 wherein the eyelet is soldered to at least one surface of the electrical circuit device.

10. A method as set forth in claim 1 wherein said step (c) of mechanically fastening the fastener to the metal substrate comprises crimping the fastener to the metal substrate.

11. A circuit device comprised of a porcelain enameled metal substrate having a conductive circuit formed thereon and an external electrical conductor attached thereto comprising a metal base coated with porcelain enamel and an aperture formed in said base, said aperture having mounted thereon a fastener, said electrical conductor being soldered to said fastener.

12. A circuit device as set forth in claim 11 wherein said external electrical conductor comprises a length of flexible copper wire.

13. A circuit device as set forth in claim 11 wherein said fastener is mechanically crimped to said metal substrate.

14. A circuit device as set forth in claim 1 wherein said fastener is electrically insulated from said metal substrate.

15. A circuit device as set forth in claim 1 wherein said metal substrate comprises low carbon steel.

16. A circuit device as set forth in claim 11 wherein said fastener is electrically connected to said conductive circuit.

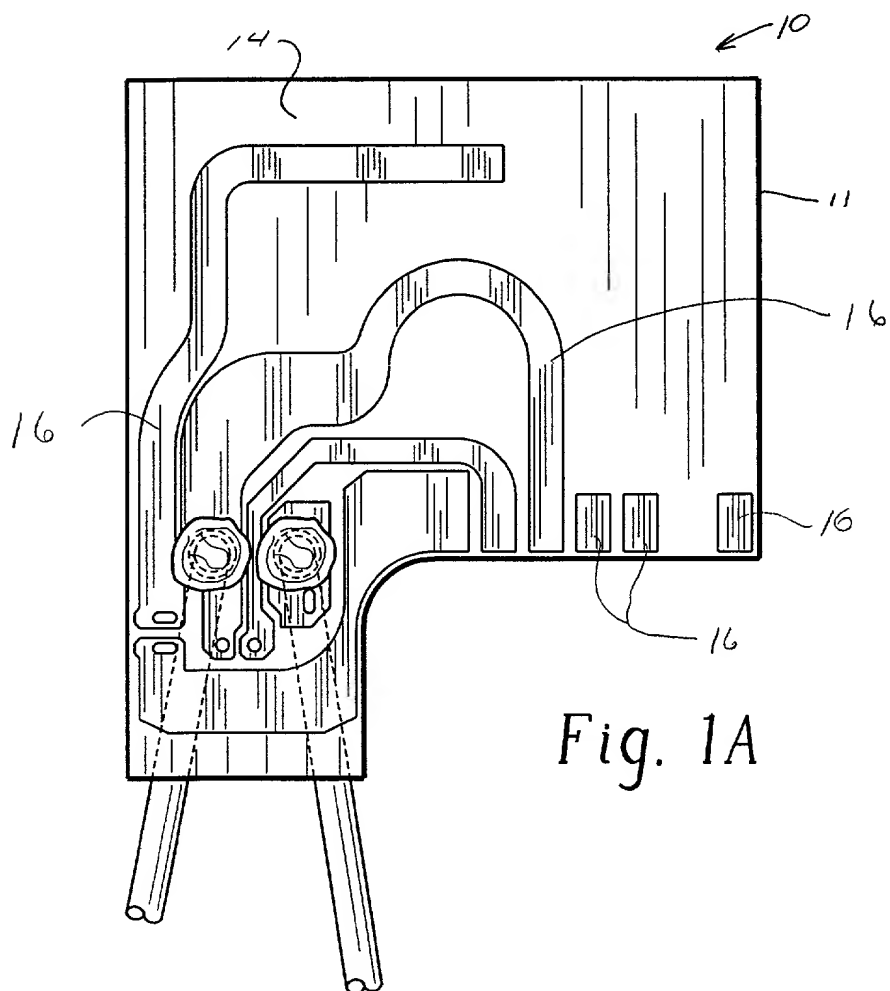
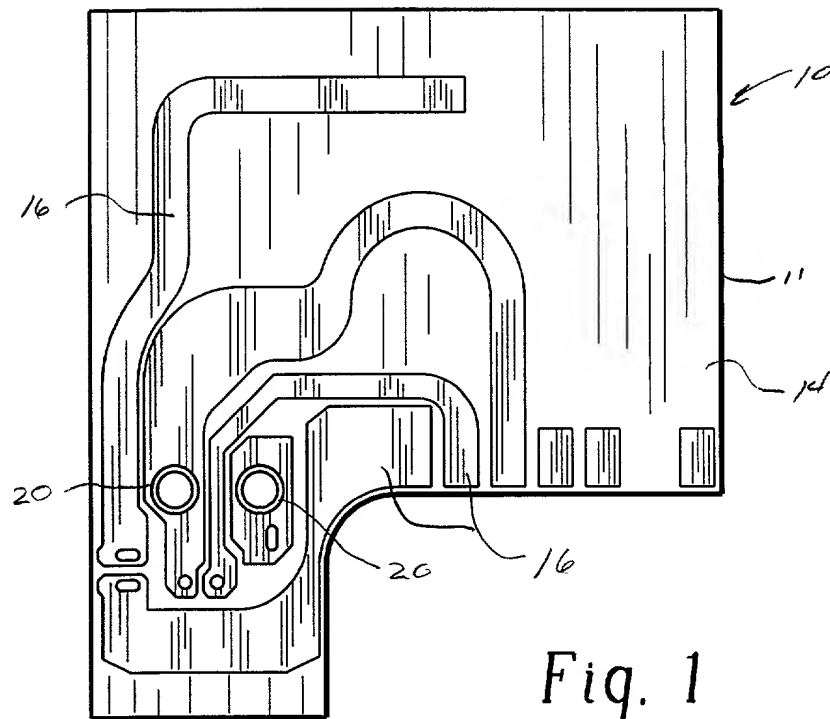
17. A circuit device as set forth in claim 11 wherein said porcelain enamel metal substrate includes two major surfaces, and said conductive circuit is formed on both of said major surfaces.

18. A circuit device comprised of a porcelain enameled metal substrate having a conductive circuit formed on each side of said substrate comprising a metal base coated with porcelain enamel and an aperture formed in said base, said aperture having mounted therein a fastener, said fastener electrically connecting said conductive circuits formed on each side of said substrate.

## **ABSTRACT OF THE DISCLOSURE**

A circuit device and a method for providing an interface between a circuit device comprised of a porcelain enameled metal substrate and an external electrical conductor such as a wire or a lead. An aperture is formed in the substrate at the location where the connection is desired. An eyelet is then placed in the aperture. Crimping or other means are used to form a mechanical connection to the substrate and causes the eyelet to be retained in the aperture. The wire or lead of an electronic component is then inserted into the eyelet. The wire or lead is then soldered to the eyelet providing a joint of high mechanical strength.

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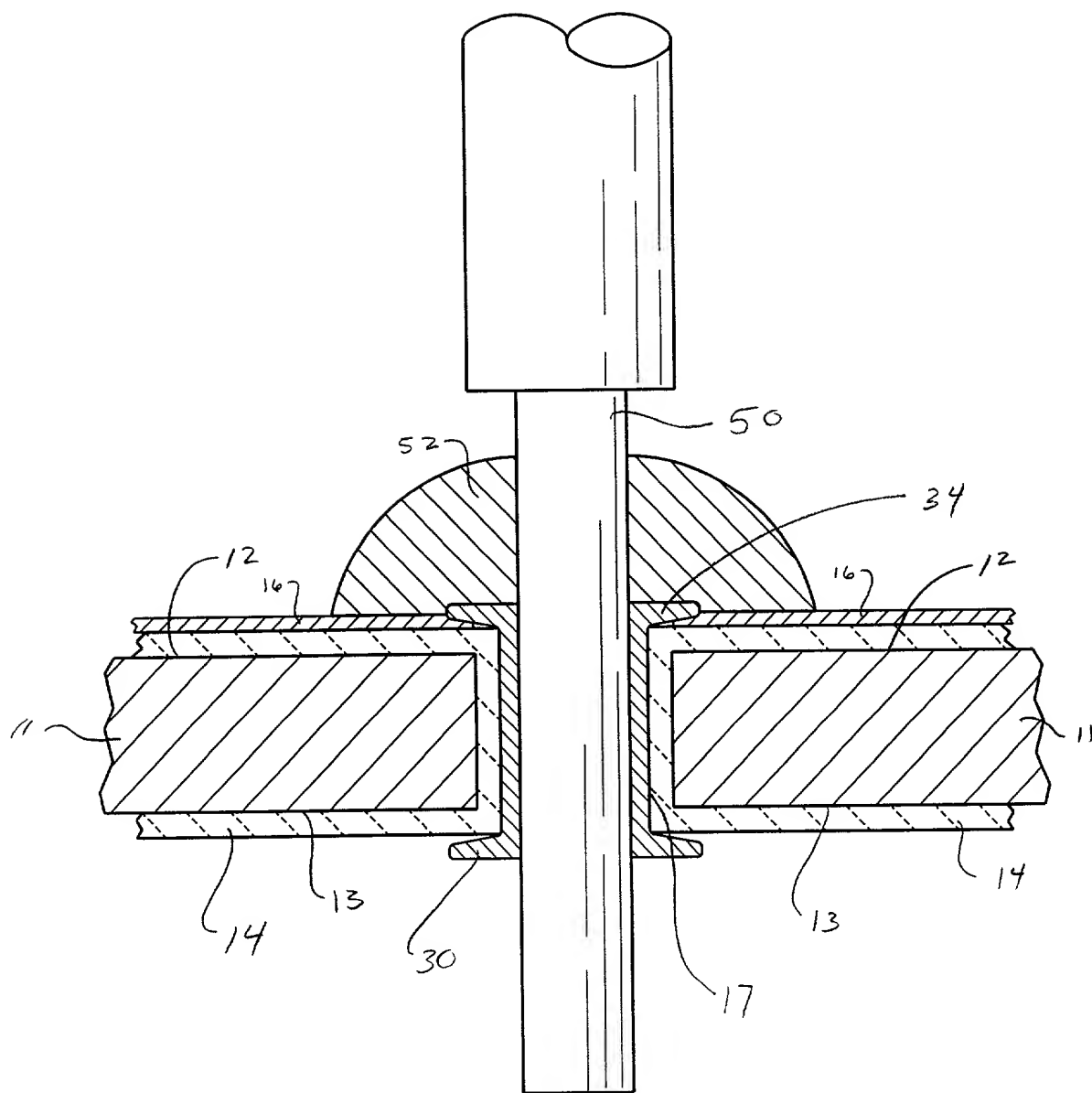


Fig. 1B

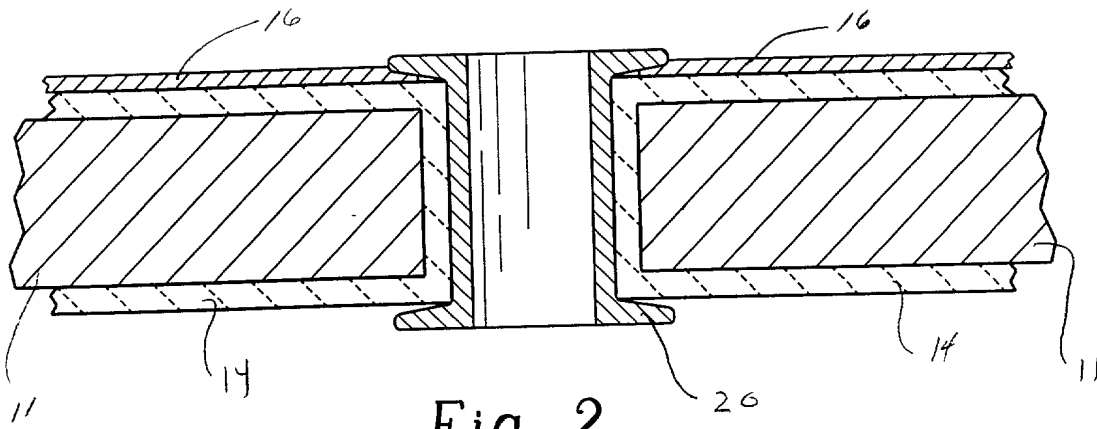


Fig. 2

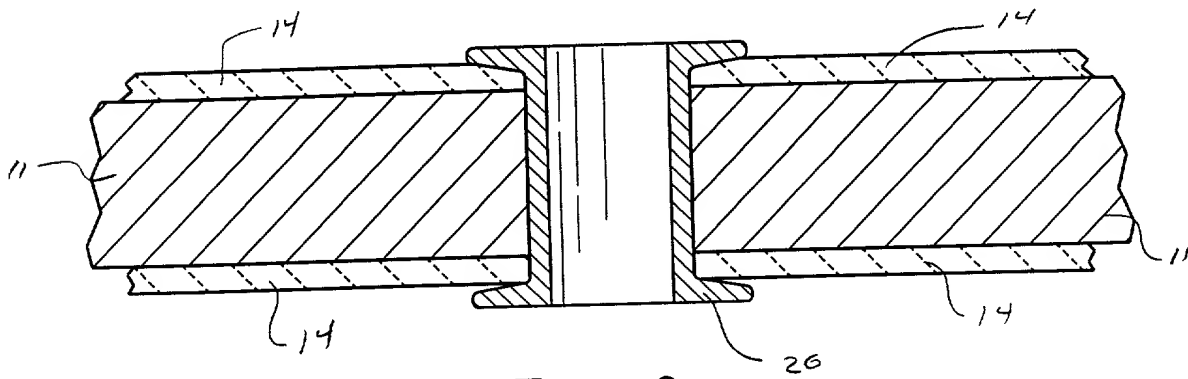


Fig. 3

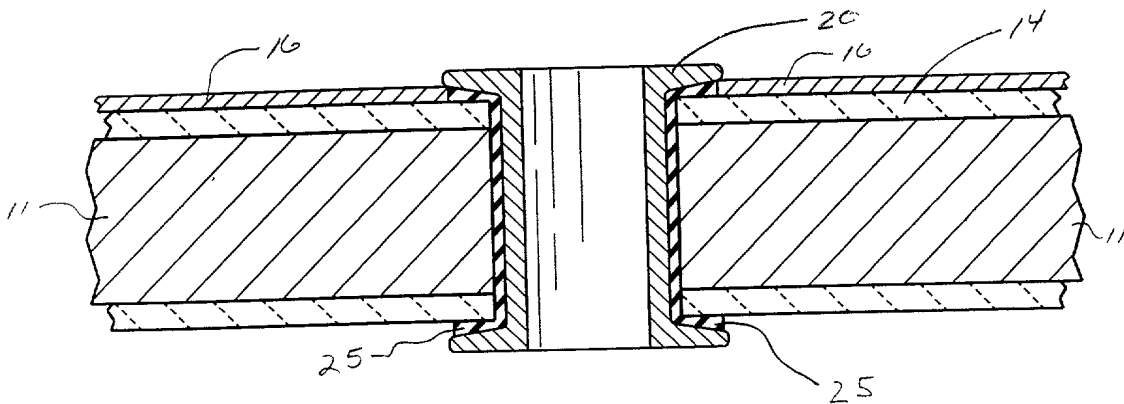


Fig. 4